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Homing Studies of Bank Swallows in Eastern Illinois

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HOMING STUDIES OF BANK SWALLOWS IN EASTERN ILLINOIS

(TITLE)

BY

JENNIFER EILEEN HAGERSTROM

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

M. S. in Zoology

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

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I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING
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HOMING STUDIES OF BANK SWALLOWS IN EASTERN ILLINOIS

BY

JENNIFER EILEEN HAGERSTROM

B. S. in Zoology, Eastern Illinois University, 1974

ABSTRACT OF A THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Science in Zoology at the Graduate School
of Eastern Illinois University

CHARLESTON, ILLINOIS
1975

A series of homing experiments using 39 color-marked Bank Swallows (Riparia riparia) were carried out in eastern Illinois during the summer of 1975. The swallow colony was located four km east-northeast of Charleston, Illinois at the Charleston Stone Quarry. Eight release sites were located in the four compass directions from the home colony at distances of 14.4 to 32.3 km away.

The colony was approached before dawn and swallows were captured using tube traps. Birds were color-marked, banded, and taken in individual bags to the release site by automobile. Cloud cover, wind velocity, wind direction, and orientation behavior were recorded for each release.

Only 1/3 of the released birds successfully homed. Of the 13 that returned, eight homed from approximately 16 km north of the home site. There was a non-random final orientation between the north and northeast compass points (chi-square = 68.6; $p<1\%$). Approximately 59% of these birds flying north-northeast homed successfully. The fastest homing velocity was 7.2 km/hr. There seemed to be no correlation between weather conditions and homing success. Swallows homed successfully under both clear and cloudy skies, and some succeeded against strong winds.

Returning swallows would typically approach the burrow several times, "hesitate" at the entrance, and finally enter the burrow. Almost immediately the swallow began to carry food or nesting material.

Some evidence exists that landmark and compass orientation were used by the swallows which homed. Evidence that landmark orientation was used is supported by the fact that sites #1 and #5 both produced

more successful returns than any other sites. This type of homing improvement is said to be typical of landmark orientation. Approximately 56% of the swallows released chose a north-northeast orientation which tends to support compass orientation. However, this orientation could have been a "nonsense" one since this orientation was not the home direction for any of the birds which flew in that direction.

Marking techniques were found to be inadequate because of poor visibility and low variability; therefore, homing success may have been better than the figures indicate. Possible solutions, although untested, include the use of colored streamers attached to the leg of the swallow or colored feathers glued to wing and tail coverts.

Homing Studies of Bank Swallows in Eastern Illinois

A series of field experiments using color-marked Bank Swallows (Riparia riparia) were carried out during the summer of 1975 in eastern Illinois to test the ability of this species to return to its nesting burrow after geographical displacement. Such colonial nesting birds were considered good test subjects since others found it practical to capture swallows in abundance during their breeding cycle (Matthews 1955, Stoner 1941, Sargent 1962, Mayhew 1963, and Downhower and Windsor 1971).

Homing experiments usually involve the removal of an adult bird from its nest and release at a distance in an area presumably unknown to it, testing the ability of that bird to undertake a flight to return to its home. Such homing experiments have existed for many centuries. The ancient Egyptians, Greeks, and Romans were known to have used Pigeons (Columba) to convey messages, but it was not until the 19th century that the full potentialities of Pigeons were known. During that time, an interest in pigeon racing, as a sport, was developed. Consequently the faster birds were bred to produce even faster ones, resulting in the development of highly successful homing strains. During that same period it was established that Pigeons would home only to the place they were raised and not to that from which their stock originated, and "home" does not appear to be permanent until after individual breeding has occurred (Matthews 1968).

Many remarkable homing flights have occurred since the homing

ability of birds was first detected. Matthews (1968) reported the longest successful flights to date as those of the Laysan Albatross (Diomedea immutabilis) which traveled 5120 km (3200 miles) in ten and twelve days. However, the Manx Shearwater (Procellaria puffinus) and Leach's Petrel (Oceanodroma leucorrhea) were not far behind with over 4800 km (3000 miles) traveled in twelve and one half days and fourteen days, respectively (Matthews 1968).

Orientation has been defined by Matthews (1968) as the behavior of a bird soon after release during a homing experiment. To study orientation, the bird is simply watched out of sight with powerful binoculars and the point at which it vanishes is noted. The first convincing demonstration of homeward orientation was obtained from racing pigeons in 1949 (Matthews 1968). It was found that thirty Pigeons (Columba livia) released successively at three unknown points in radically different directions were consistently lost to sight in the homeward direction.

Several projects in which conditions of the environment were artifically altered to test for orientation cues were conducted by ornithologists. Kramer (1957, 1959) placed the Pigeon's aviary in a large bomb crater or erected an opaque palisade all around and slightly higher than the aviary, thus depriving the Pigeons of any view of the surrounding landmarks. Of 133 released birds, 53 gave a homeward orientation, but not a single bird homed. Kramer suggests that the initial orientation was a "nonsense" one. "Nonsense" orientation is defined as an orientation taken regardless of where the bird was released.

Kramer (1961) also studied the mechanism of diurnal direction finding by using the Starling (Sturnus vulgaris) and a round apparatus, two feet in diameter, which could be viewed from below. By observing the birds display of "fluttering" activity the observer could determine if the direction of activity corresponded to the direction of migration in the wild. He found that if the sky was completely overcast, migratory activity was diffuse. Furthermore, when the direction of the sunlight was changed by reflecting it with mirrors, the bird shifted its direction accordingly; it was thus demonstrated that use is made of the sun in orientation.

Sauer (Griffin 1964) studied some nocturnal migrants, the European warblers, in an apparatus similar to Kramer's under both a natural sky and under a planetarium. The warblers showed consistent directional tendencies that corresponded to the normal migratory headings. As in Kramer's experiments, cloudy skies elicited only disoriented and random choices. Evidently these warblers based their selection of migratory directions on the patterns of stars. Furthermore, these directional choices were reversed with the season.

Emlen (1967) tested captive Indigo Buntings (Passerina cyanea) for orientation cues. He placed the birds in a type of unit in which they were able to see the sky overhead but the horizon was blocked from view. When he exposed the buntings to planetarium skies that were advanced and retarded 3, 6, and 12 hours from local time, they continued to maintain their normal migration direction. Emlen concluded that the birds were not relying upon bicoordinate celestial navigation system; neither were they employing a form of time-compensation analogous

to that proposed in sun-compass orientation. He concluded that buntings determine the migration direction by responding to Gestalt stimuli provided by star patterns.

Even with convincing experiments like these, the mechanism by which navigation is accomplished is still debated by various experts in the field. Walcott (1974) concluded, after experimenting with Pigeons, that birds used landmarks, a sun compass, a magnetic compass, and olfactory cues while navigating. Matthews (1968) gives a very good summary of the various theories and their authors in his book Bird Navigation, to which I refer the reader.

Previous studies indicate that some species of Hirundinidae have a well-developed homing ability. Sargent (1962) reports that Rüppell worked on homing experiments with the Barn Swallow (Hirundo rustica) in Germany. Over several years Rüppell released 56 Barn Swallows at distances ranging from 276 to 1875 km of which 40% returned. The maximum speed of return was 412 km per day.

The Barn Swallow was also used by Wojtusiak and Ferens in homing experiments in Poland (Sargent 1962). They found that swallows released at distances up to 152 km from their nests returned in the same day. It was also found that adverse conditions (rain, strong winds) diminished the homing velocity.

A Rough-winged Swallow (Stelgidopteryx ruficollis) was tested for its homing ability by Gillespie (1934). On two different occasions this bird homed from 6.4 and 52.5 km, always within 12 hours.

Southern (1959) used the Purple Martin (Progne subis) in 16 homing trials. All 16 birds returned from distances of 2.8 to 376 km

from the home site. They were released during rain storms, cloudy and clear skies, and cloudy and clear nights.

Homing studies on Bank Swallows have been reported by several investigators. Matthews (1955) reported the results of 35 releases in England and Germany. Thirty-seven percent of the birds released returned to their nests from distances up to 107.2 km.

Downhower and Windsor (1971) did a homing study on the Bank Swallows of the Lake Cayuga area of New York. Their hypothesis was that swallows use landmarks to some degree while homing. To test this hypothesis they released swallows from five different colonies in various distances and directions from the home sites. During one release they took the swallows from a colony on the east side of Lake Cayuga to the west side of Lake Seneca, west of Lake Cayuga. If the swallows did use large bodies of water as landmark guides while homing, they would have flown to the east side of Lake Seneca and stopped because the two bodies of water were very similar. However, if they homed by means other than landmark guides they would have flown on to Lake Cayuga. Downhower and Windsor's experiment indicated that most Bank Swallows are familiar with landmarks 5 km or less from the home bank. However, other cues were used for distances greater than 5 km from home.

A total of 304 Bank Swallows were released by Sargent (1962) at distances ranging from 1.6 to 282 km from the home colony. The swallows were captured at their burrows before daybreak, transported by car, and released individually. Over 80% of the birds returned from distances less than 80 km away while less than 40% of the birds released at 80-160 km returned. Initial homeward orientation was

demonstrated by swallows released at distances under 80 km and orientation was not affected by wind. However, a random pattern of orientation was displayed at releases beyond 80 km from home and a strong downwind effect was recorded. Sargent (1962) also found that birds upon release showed no tendency to fly in any one compass direction. He concluded that random search patterns and landmark recognition are used by displaced Bank Swallows in homing.

A single release of 13 Bank Swallows 81 km north of the home colony was made by Mayhew (1963). He found that 30% of the birds returned under overcast skies in 23 to 25 daylight hours and they indicated by their direction of flight on release that they did not know the direction of the home colony at the time of release. Mayhew concluded that random search patterns were used by the Bank Swallows to navigate from areas outside of familiar territory.

In the present study four aspects of homing ability were studied: (1) orientation upon release, (2) homing ability under different weather conditions, (3) possible use of familiar watersheds as navigational aids, and (4) homing success from different directions and distances.

Materials and Methods

The swallow colony was located 4 km (2.5 miles) east-northeast of Charleston, Illinois at the Charleston Stone Quarry (Section 5, T12N, R10E, Coles County, Illinois). During recent years extensive sand and gravel excavations each summer have caused the exact location of the Bank Swallow colony to vary. The colony was relocated several times this summer due to both excavation and rain storms which

caused land slides. The nesting birds seemed to prefer areas of recent excavation.

Eight release sites were used varying from 14.4 to 32.3 km from the home site (Table 1). Release sites 1-4 were located along the Embarras watershed; sites 5-8 were located east, north, and west of the home colony (Fig. 1). All distances, locations, and directions were found using a cartometer, protractor, and county maps of the area.

The colony was examined before each experiment to determine the exact location of nesting birds and the height of the colony from the ground. Within a few days after examination, the colony was approached before dawn and using a 30-foot ladder to gain access to the burrows, a large number of burrows were stuffed with newspapers. Then using a flashlight to ascertain the presence of a bird within the burrow, I replaced the newspaper with a trap like that developed by Morris (1942). Each trap consisted of a rolled piece of cardboard approximately 20 cm x 36 cm with a perforated plastic bread sack attached to the end by means of a rubber band. When a swallow flew into a trap the cardboard was removed, a slip of paper containing a color code was inserted, and the bag was closed with a rubber band. Colored yarn corresponding to the above color code was tied to a stick and imbedded in the bank above and to the right of the burrow for later recognition.

Each bird was banded with a U. S. Fish and Wildlife Service band and its tail was spray-painted with the same color code used to identify the burrow. "Glowz" florescent paint in cerise red, yellow

orange, and signal green and Testor's Spray Pla enamel in yellow were the four colors used. The breast was spray-painted in the brighter of the tail colors used if more than one color was used on the tail.

After the band number and marking patterns were recorded, the birds were placed back into their bags. The bags were securely closed with rubber bands and then placed in a wire cage for transport. This entire procedure usually took two to two and a half hours.

The birds were transported to the release point by automobile and then released singly, alternating the direction of release and holding the bag overhead for each release. Time of release was noted and flight of the bird was followed with 7 x 35 binoculars. The amount of cloud cover, wind direction, wind velocity, and initial and final orientation was recorded for each release.

The home burrows were observed at a distance of approximately 60-65 meters for four hours after the release of the birds. All returns of birds to marked burrows and any observed color-patterns of these birds were recorded. If no birds returned during the observation period, the burrows were checked the following day with a flashlight and attempts were made to retrap occupants of marked burrows.

Results

During this study 39 Bank Swallows were trapped and released at eight release sites (Fig. 1) ranging from 14.4 to 32.3 km from the home colony (Table 1). The distance from the home colony is increased considerably by following the Embarras rather than a straight route from the release sites (Table 1). As Table 2 shows, 13 of the swallows returned to the colony. Almost half of the birds released 14.4 to 16.2

km from the home site returned while only 13% of the birds released 30.4 to 32.3 km away returned.

Site # 1 had the highest rate of return with all four released birds returning. The rate of return from the other sites ranged from very poor (site #8) to moderate success (site # 7) (Table 2).

When released the swallows would usually fly out of the bag, circle about, and be lost to sight within two to five minutes. The direction in which they were last seen was the orientation direction recorded (Fig. 2). On one occasion, during release from site # 2, the birds flew out of the bag and flying low to the ground, either landed or were lost to sight.

Homing success varied from very poor to good during different parts of the breeding season (Table 2). All of the birds released early in the season on June 3 returned. However, during the middle of the season very poor homing rates were recorded (June 12, 16, 17, and 23). But results improved again towards the end of the breeding cycle (July 9 and 14).

Fig. 3 presents an analysis to determine whether the swallows had any tendency to choose one constant compass direction when released. There tends to be a non-random distribution between the north and northeast compass points (chi-square = 68.6; $p<1\%$). Approximately 59% of those birds flying north-northeast homed successfully. However, of the birds which should have flown north-northeast to home, not a single bird which oriented in that direction homed successfully (Fig. 2, A).

Only 6 of the 39 swallows homed within 24 hours after release.

The fastest homing velocity was 7.2 km/hr. from release site #1. It is impossible to state the homing velocity of the other successful homing swallows because I did not know they had homed until I retrapped them, anywhere from one to three weeks after release.

Four of the birds which homed within 3 hours did so under almost complete cloud cover (75-100%) and the sun was invisible upon release. On the other hand, two other birds released under clear to scattered skies (25% cloud cover) homed within 24 hours. Wind velocity in seven of the eight releases was 0-8 km/hr. Results varied from 0-100% success during these seven releases. During the other release period, from site #2, the wind velocity was 24 km/hr. and only one of the six releases homed successfully.

Swallows which returned to the home colony during observation periods often displayed a different type of behavior than those swallows which had never been used in homing experiments. They flew to the burrow, "hesitated" at the opening, and flew away. After several approaches, with occasional landings on the edge of the opening, the bird would enter the burrow. The swallow would usually begin to carry nesting material or food to the young. Rarely did a bird enter the burrow and fail to reappear.

Discussion

During this study 39 Bank Swallows were trapped and released at distances varying from 14.4 to 32.3 km from the home colony. It is doubtful that any of the release sites were too far for the Bank Swallows' homing ability since Sargent (1962) reported homing success for this species from distances of 280 km from the home site. Release

sites 1 through 4 were chosen because of their proximity to the Embarras River Valley. I was trying to determine if Bank Swallows used waterways as landmark guides in homing. The results from release sites 1-4 showed no more successful returns than from the four non-watershed points. However, site #1, located along the Embarras, showed 100% successful homing. This could have been because the swallows use the areas along the Embarras River north of their home as a foraging area for insects, the main diet of Bank Swallows (Stoner 1932).

Another factor, which could have influenced the return rate from site #2, was the weather conditions. Wind velocity was approximately 24 km/hr. during that release period causing the birds to fly low to the ground and land soon after release. Sargent (1962) reports that wind velocities over 8 km/hr. affected the initial orientation of swallows released at distances where homeward orientation was lacking. However, he also reports that some of the fastest homing flights were made against head winds. The homing speeds of Bank Swallows are so slow that speed is not considered to be an indicator of homing ability. However, almost half of the birds which homed did so within 24 hours.

No successful returns were recorded from site #3. This site, approximately 15 km south of the home colony, was located near a gravel quarry where Bank Swallows had been known to nest in earlier years. A number of Bank Swallows could be seen in the area on both release dates. One swallow, upon release, did join a Bank Swallow already in the air for a short time during its initial orientation flight. Since this release site was no farther than other sites which swallows had successfully returned from, it is doubtful that the swallows found it impossible to home.

The only other release site which showed good return rates was site #5. Although it was not located along the Embarras River, the site was to the north and in the 15 km range, as was site #1. If the swallows did forage along the Embarras River, they may have been familiar with site #5, just 10 km west of site #1.

Orientation

Griffin (1955) recognizes three types of orientation in birds:

Type I. The use of random search patterns and familiar landmarks.

Type II. The ability to choose a constant compass direction.

Type III. True navigation: the ability to recognize displacement in any direction with respect to a particular geographical point.

Evidence that landmark orientation was used is supported by the fact that site #1 and site #5 both produced more successful returns than any other sites. Both of these sites were approximately 15 km northward from the home site. According to Sargent (1962), such homing improvement is expected when a landmark orientation is involved.

Evidence that compass orientation exists is supported by Fig. 3. Over 59% of those birds which chose a north-northeast direction homed successfully. However, this could have been the "nonsense" orientation mentioned by both Kramer (1957, 1959) and Matthews (1968) since this orientation was not the home direction for any of the birds which flew in that direction.

No evidence was found for the use of true navigation in my study. However, since no release points of any great length were used, I do not feel qualified to rule out true navigation completely.

Marking

The rate of return may not have been as poor as my data indicate because of inadequate marking techniques. It was very difficult to determine the tail colors from any distance, especially the green and yellow, and color combinations were limited. The burrow the marked bird inhabited also had to be determined since these same color patterns were used for more than one experiment. If future homing experiments on small birds, such as the Bank Swallow, are attempted, I would recommend several changes.

Since no marking techniques can be used which alter the ability of the bird to fly, both wing tags (Knowlton et al. 1964) and back tags (Gullion et al. 1962) such as those used on game birds are excluded. Neck bands are also not available for use because only geese can have articles around the neck (Sherwood 1966). Wing marking studies were carried out by Samuel (1970) on Barn and Cliff Swallows (Petrochelidon pyrrhonota) in which he developed a way of marking 48 individuals using the five outer remiges. However, I did not want to impair the swallows' flight ability in any way so wing markings were ruled out. Ellis and Ellis (1975) used a blue cream lightener on Golden Eagles (Aquila chrysaetos) with good results. However, the process is time consuming (approximately 30 minutes to dye each bird) and has not been tested on birds as small as swallows.

A possible solution to the marking problem, although it has not been documented, is the use of colored yarn or plastic streamers attached to the leg of the swallow. Since the marking only has to be temporary, it would not matter if the swallow removed or lost the streamer after 24-48 hours. The experimenter should recapture the swallow and remove

the marker to prevent the bird from getting the marker caught on something and causing injury to the bird, although recapturing is not always easy to accomplish.

Another successful marking technique, used by Sargent (1962), was the use of dyed feathers glued to the upper tail and wing coverts. Since he reported a high rate of homing success, this technique must have been very useful.

Problems were compounded by the relocation of burrows. Four different colonies were established during the summer because the old ones were either demolished by the quarry workers or by the rain. Earlier color-marked birds often turned up in entirely different burrows at later dates due to these renesting attempts.

Another indication of the swallows' difficulty in completing their breeding cycle was the late nestling dates. Young swallows were still in the nest as late as July 14, almost two weeks later than Bent's (1942) projected nestling dates.

Trapping

Of the literature I reviewed, few mentioned any trouble with trapping techniques. I had trouble getting all birds to exit during initial trapping attempts. This could often be alleviated by making sure the bag on the trap was clear plastic or, if this failed, replacing the trap with a mesh butterfly net. Mayhew (1963) modified Morris' trap by using a 6 oz. fruit juice can with both ends cut out instead of cardboard. This enabled him to work at night when the moisture level was high. He found he got best results by shining a light into the trap for a few minutes and then turning the light off. As a rule, the swallows could be trapped twice before they became "wary"

of the trap and refused to exit. I admit that retrapping was not an easy endeavor.

I started trapping on May 31. This is probably too early because most of the swallows were still excavating their first burrows. However, by June 3, I was getting a high rate of homing success. The frequency of trapping is directly related to colony activity; therefore, observation period should be carried out frequently to determine if the swallows have relocated, are in the nest carrying, or in the food carrying cycle. If the burrows are relocated, you should wait a few days until the swallows get the new burrows excavated and start incubating a new brood of eggs.

Trapping should be concentrated during June because this is the swallows' peak month of activity. However, the inclination to home is still very good until the middle of July. After that, most of the burrows are deserted with the swallows evidently sleeping in the shrubby vegetation surrounding the quarry. Mayhew (1963) also reports that the nesting colony he used was deserted by July 16. The colony I used did not seem to be upset by frequent trappings, but I suggest an interval of 48 hours between experiments.

Since I did not have any person available to share observation periods, the most time spent observing was approximately 4 hours. However, if future experiments are conducted, I recommend that several people do the project so that observation periods can be extended to sunset.

Table 1. Location, distance, and direction of release sites of Bank Swallows from the home colony near Charleston, Illinois.[1/]

Site	Location				Distance in km		Direction to home site(°)
	Section	TWP	Range	County	Straight	By water	
1	14	14N	10E	Coles	16.2	27.5	190
2	33	15N	9E	Douglas	32.3	48.0	179
3	23	11N	9E	Cumberland	16.0	24.6	18
4	32	9N	9E	Cumberland	30.4	47.7	13
5	26	14N	9E	Douglas	16.0	-	160
6	27	13N	14W	Edgar	14.4	-	255
7	3	12N	8E	Coles	15.4	-	90
8	31	13N	7E	Coles	30.4	-	95

[1/] 1 mile = 1.6 kilometers (km)

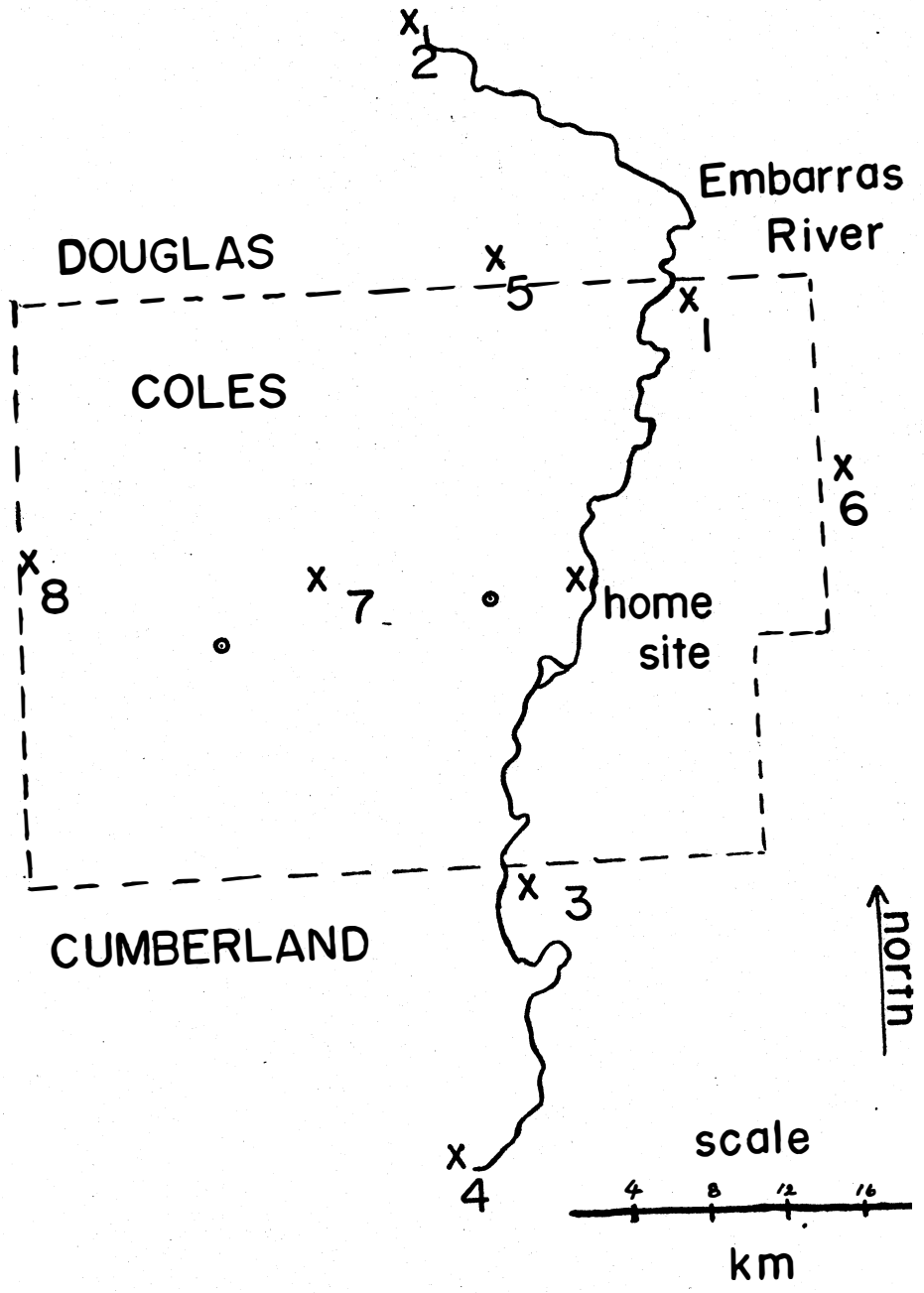
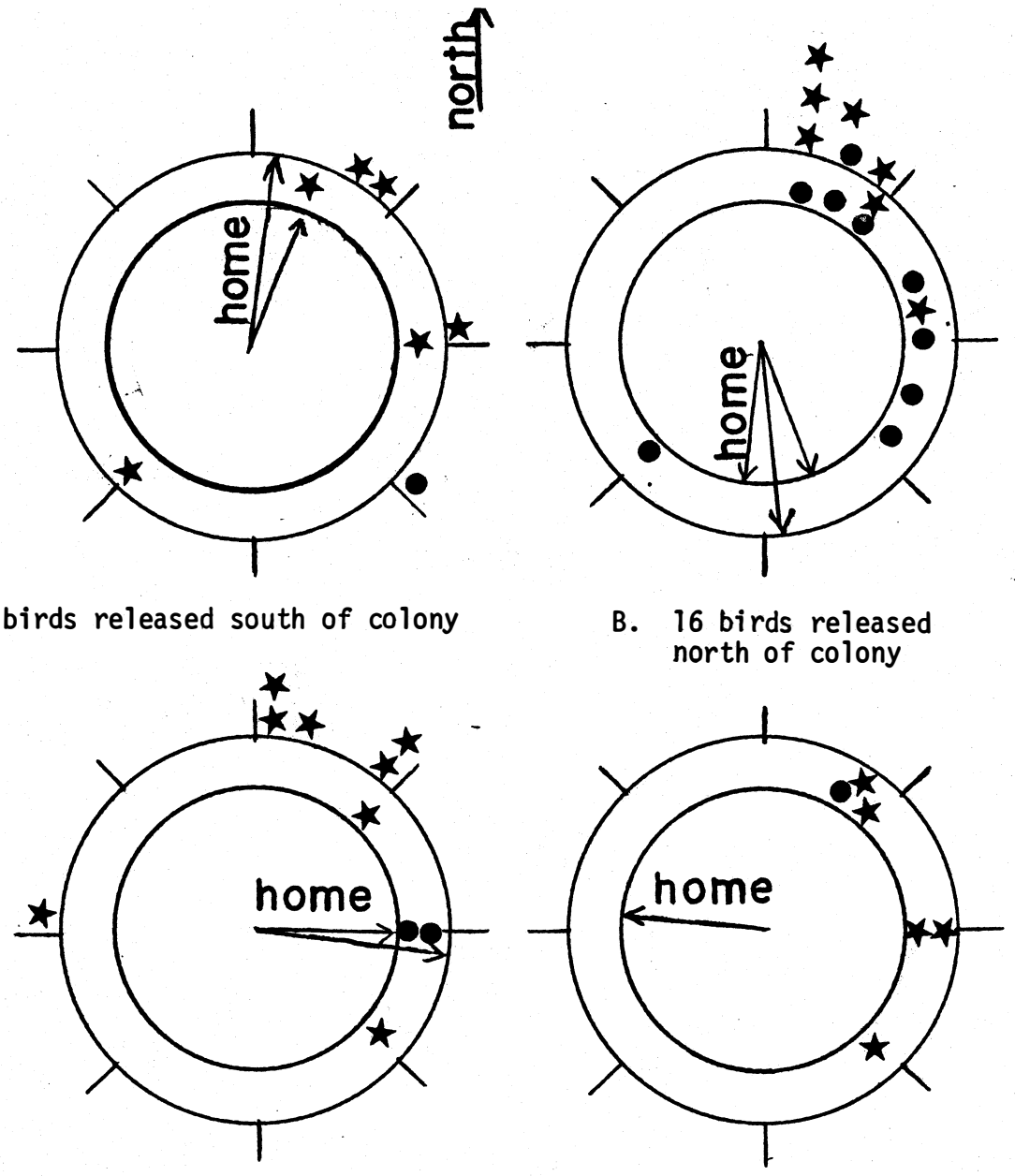


Figure 1. The location of eight release sites for 39 Bank Swallows from the home site near Charleston, Illinois.

Table 2. Numbers of Bank Swallows released and successfully homing from eight release sites in four directions from the home colony.

Release Direction	Site	Date	Number Released	Number Returned
SHORT DISTANCE (± 15 km)				
North	1	6/3	4	4
	5	7/9	6	4
East	6	6/23	6	1
South	3	1/	3	0
West	7	7/14	4	2
Subtotal			23	11
LONG DISTANCE (± 30 km)				
North	2	6/17	6	1
South	4	6/12	4	1
West	8	6/16	6	0
Subtotal			16	2
Totals			39	13

1/ Releases were made from site #3 on two dates 5/31 and 6/6.



A. 7 birds released south of colony

B. 16 birds released north of colony

C. 10 birds released west of colony

D. 6 birds released east of colony

Figure 2. The disappearance points for 39 Bank Swallows. Inner circles reflect swallows released approximately 15 km from the home site and outer circles depict swallows released approximately 30 km from home. The small circles represent those birds which successfully homed. (Circle D had no 30 km release.)

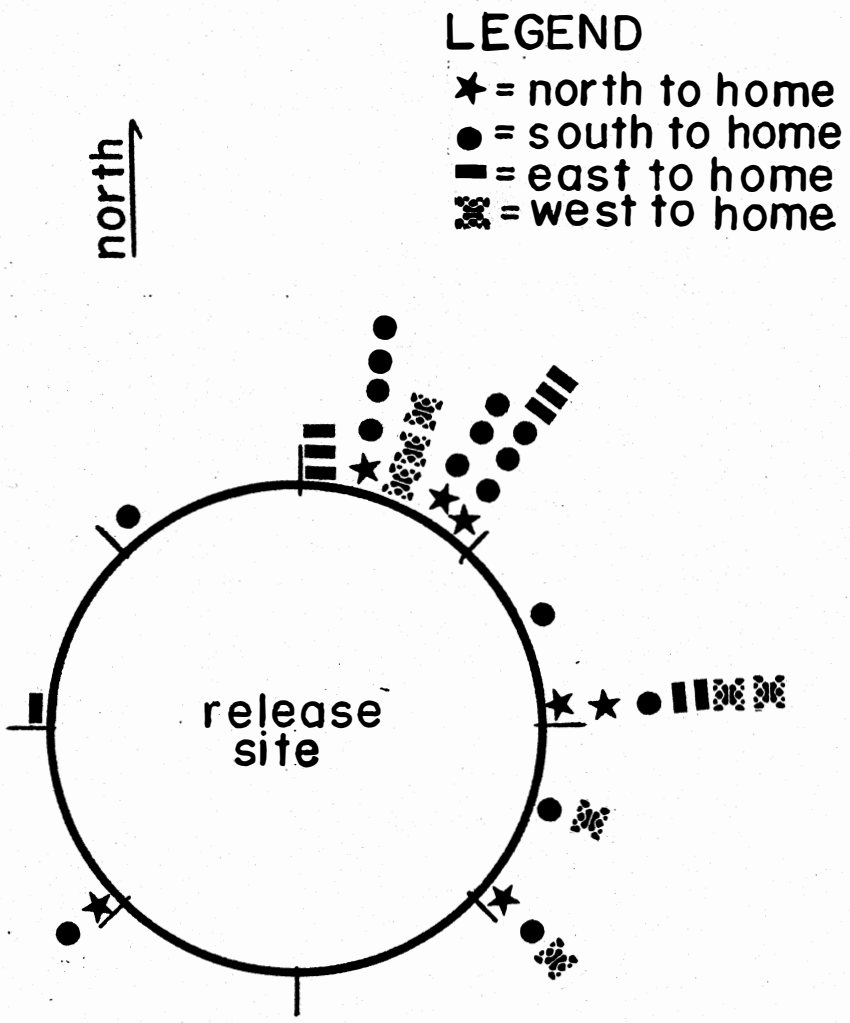


Figure 3. The disappearance points for 39 Bank Swallows with respect to release sites. Symbols indicate the direction the birds should go to reach the home site.

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